APPROXIMATION OF BLOOD SUGAR WITHOUT USING BLOOD

(BLOODLESS GLUCOMETER)

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Abstract−

As we know that today most of the human beings suffer from one of the dangerous disease called as Diabetes. It is a dangerous disease which results in the loss of life of human being. So a continues monitoring of the blood sugar level for a diabetic patient is very important. All the techniques which have already been invented measure the blood sugar by taking a sample of blood from the body which is painful and simultaneously results in loss of blood. This is because if a patient has to be tested for blood sugar, it will cause blood loss of 10-15 drops for the human body. The amount of sugar present in human body can also be determined through urine. The advantage of this type of measurement is that this method is neither painful nor it results in loss of blood from human body. This test is valid depending upon the function of kidneys. In this paper an attempt has been made to estimate the blood sugar level through urine using electrodes and quadruple amplifying the variations from no sugar to maximum sugar level.

Key words: Glucometer, Diabetes, Insulin, Type 1 Diabetes, Type 2 Diabetes , HbA1C test.

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INTRODUCTION

Insulin is a hormone produced by the pancreas to control blood sugar. Diabetes can be caused by too little insulin, resistance to insulin, or both. To understand diabetes, it is important to first understand the normal process by which food is broken down and used by the body for energy. Several things happen when food is digested:

- A sugar called glucose enters the bloodstream. Glucose is a source of fuel for the body.

- An organ called the pancreas makes insulin. The role of insulin is to move glucose from the bloodstream into muscle, fat, and liver cells, where it can be used as fuel.

People with diabetes have high blood sugar because their body cannot move sugar into fat, liver, and muscle cells to be stored for energy. This is because either:

- Their pancreas does not make enough insulin

- Their cells do not respond to insulin normally

- Both of the above

There are three major types of diabetes. The causes and risk factors are different for each type:

1. Type 1 Diabetes**:** It can occur at any age, but it is most often diagnosed in children, teens, or young adults. In this disease, the body makes little or no insulin. Daily injections of insulin are needed. The exact cause is unknown.

2. Type 2 Diabetes: It makes up most of diabetes cases. It most often occurs in adulthood, but teens and young adults are now being diagnosed with it because of high obesity rates. Many people with type 2 diabetes do not know they have it.

3. Gestational diabetes: It is high blood sugar that develops at any time during pregnancy in a woman who does not have diabetes.

Insulin is a hormone responsible for regulating carbohydrate and fat metabolism in the body. Insulin causes cells in the liver, muscle, and fat tissue to take up glucose from the blood, storing it as glycogen in the liver and muscle. Insulin stops the use of fat as an energy source by inhibiting the release of glucagon. When blood glucose levels fall below a certain level, the body begins to use stored sugar as an energy source through glycogenolysis, which breaks down the glycogen stored in the liver and muscles into glucose which can then be utilized as an energy

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source. Patients with type 1 diabetes depend on external insulin (most commonly injected subcutaneously) for their survival because the hormone is no longer produced internally. Patients with type 2 diabetes are often insulin resistant and, because of such resistance, may suffer from a "relative" insulin deficiency. Some patients with type 2 diabetes may eventually require insulin if other medications fail to control blood glucose levels adequately.

High blood sugar levels can cause several symptoms, including:

- Blurry vision

- Excess thirst

- Fatigue

- Frequent urination

- Hunger

- Weight loss

METHODS OF MEASURING BLOOD SUGAR

The use of an inexpensive glucometer and blood glucose testing at home can help avoid dangerous insulin overdoses and can provide a better picture of how well the condition is managed. Dr. Sara Ford gave a presentation about the need for home blood glucose testing in diabetic pets at the 2010 American Veterinary Medical Association Convention. She believes a diabetic pet needs to be checked at least twice a day, saying, "If you're a human diabetic you monitor your blood sugar between 4-6 times a days."

This test measures both ketones and glucose in urine. A 2003 study of canine diabetes caregivers who were new to testing blood glucose at home found 85% of them were able to both succeed at testing and to continue it on a long-term basis. Using only one blood glucose reading as the reason for an insulin dose increase is to be avoided; while the results may be higher than desired, further information, such as the lowest blood glucose reading or nadir, should be available to prevent possible hypoglycemia.

Glucometers made for humans are generally accurate using canine and feline blood except when reading lower ranges of blood glucose (<80 mg/dL), (<4.44 mmol/L). It is at this point where the

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size difference in human vs. animal red blood cells can create inaccurate readings. Glucometers for humans were successfully used with pets long before animal-oriented meters were produced A 2009 study directly compared readings from both types of glucometers to those of a chemistry analyzer. Neither glucometer's readings exactly matched those of the analyzer, but the differences of both were not clinically significant when compared to analyzer results. All glucometer readings need to be compared to same sample laboratory values to determine accuracy.
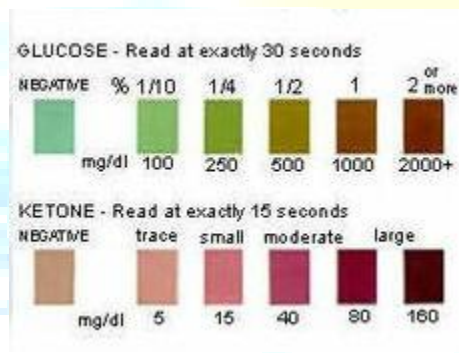

Fig 1: Ketodiastix color chart for interpreting test results

Glycosolated hemoglobin (hemoglobin A1c, HbA1c, A1C, or Hb1c; sometimes also HbA1c) is a form of hemoglobin that is measured primarily to identify the average plasma glucose concentration over prolonged periods of time.. As the average amount of plasma glucose increases, the fraction of glycosolated hemoglobin increases in a predictable way. This serves as a marker for average blood glucose levels over the previous months prior to the measurement .In the normal 120-day lifespan of the red blood cell, glucose molecules react with hemoglobin, forming glycosolated hemoglobin. In individuals with poorly controlled diabetes, the quantities of this glycosolated hemoglobin are much higher than in healthy people. .The International Diabetes Federation and American College of Endocrinology recommend HbA1c values below 48 mmol/mol (6.5%), while American Diabetes Association recommends that the HbA1c be below 53 mmol/mol (7.0%) as the reference range for the diabetic patient.

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BLOOD GLUCOSE GUIDELINES

The numbers on the table below are as shown on a typical home glucometer. Seeing ketone values above trace or small is an indication to contact a vet or local emergency treatment center.

Table 1

mmol/L	mg/dL	Blood Glucose Guidelines
<2.77	<50	Readings at or below this level are considered hypoglycemic when using insulin,even without visible hypoglycemia symptoms. Immediate treatment is needed.
3.44–6	62–108	Normal glucose values range for dogs who do not have diabetes
5	90	Commonly cited minimum safe value for the lowest target blood sugar of the day when insulin-controlled.
5.5–10	100–180	Commonly used target range for diabetics, for as much of the time as possible.
10	180	Renal threshold for dogs when excess glucose in the blood spills into the urine.The kidneys are unable to reabsorb it all; corresponding diabetic symptoms appear.
14	250	Approximate maximum safe value for the highest blood sugar of the day. Dogs can form cataracts at this level and need to be checked for ketones using urine strips.Higher blood glucose levels indicate a lack of sufficient insulin.The body can switch from using ketones instead of glucose for fuel
16.7	300	Ketone monitoring is needed at this level. High blood glucose values increase the risk of the body switching to using ketones for energy.

>20	>360	Ketones need frequent monitoring due to the increasing insulin deficit illustrated by high glucose readings.As blood glucose values increase, so does the possibility for ketone production. Both short and long-term ill effects are possible- see hyperglycemia for details.

For most people, good blood sugar levels are:

Table 2

On waking up (before breakfast)	80 to 120
Before meals	80 to 120
2 hours after meals	160 or less
At bedtime	100 to 140

GLUCOMETRY

Glucometry is a technique for obtaining the value of concentration of glucose in peripheral or central blood. These values expressed either in mg/dl or mmol have important clinical value for metabolic disorders such as diabetes mellitus, denutrition, and some of their consequences like hyperosmolar coma, malabsorption syndrome and the most critical – hypoglycemia, lower than normal level of blood glucose.

A glucometer is a medical device for measuring levels of glucose concentration in the blood, depending on the level, administration of an hypoglycemiant drug might be required for the patient. A glucometer will use a test strip to interact with a patient's drop of blood. The needle shown in the figure is used to take out few drops of blood when it is pinched in the human body with the help of the glucometer pen which is shown in the figure below.A chemical reaction is

produced and the meter reads the level of glucose expressed in mg/dl or mmol/l. The glucometer is usually portable and is used at home for monitoring diabetic patients. A glucometer, and proper pharmaceutical treatment, is fundamental for a diabetic patient to maintain glycemic control at home.

Fig 2: Glucometer   **Fig 3: Test Strip**   **Fig 4: Needle**

The equipment should be portable and low power. For type 1 diabetes patients, the glucometer should include features that are easy-to-use and that enhance the experience. Old patients may prefer a device that is easy to grab in order to avoid dropping and has larger numbers in the. These requirements directly impact technology and the glucometer niche market.

Fig 5: Glucometer Pen

The first step to measure glucose in the blood is to convert the glucose concentration into a voltage or current signal, this is possible with special sensor strips for amperometry. The sensor uses a platinum and silver electrode to form part of an electric circuit where hydrogen peroxide is electrolyzed.

The hydrogen peroxide is produced as a result of the oxidation of glucose on a glucose oxide membrane. The current flowing through the circuit provides a measurement of the concentration of hydrogen peroxide, giving the glucose concentration.

It is important to highlight that the expressed relationship in the reaction (**Figure 6 below**) is linear. This is different in reality since other biochemical substances might be involved in the reaction as well.
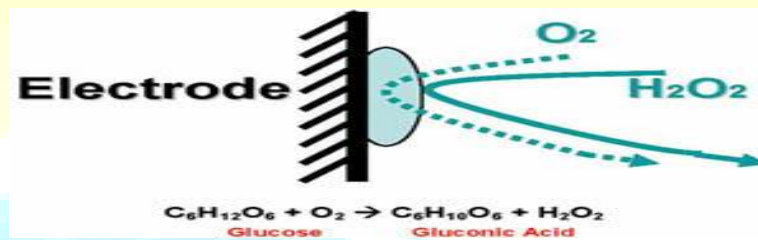

$$C_6H_{12}O_6 + O_2 \rightarrow C_6H_{10}O_6 + H_2O_2$$

Fig 6: Electrodereaction

Sensor used as a blood glucose meter is based on a glucose oxide electrode. The glucose oxides are immobilized in a platinized activated carbon electrode. The enzyme electrode is used for amperometry determination by using an electrochemical detection of enzymically produced hydrogen peroxide.The sensor is composed of various electrodes: a glucose oxide membrane layer, a polyurethane film that is permeable by the glucose, oxygen, and hydrogen peroxide. Amperometry measures electric current between a pair of electrodes which drives the electrolysis reaction. Oxygen diffuses through the membrane and a voltage is applied to the Pt electrode reducing O_2 to H_2.

OBJECTIVE

Our objective is to measure the blood sugar without using blood of the human body. It is a new method of measuring the blood sugar. More than 65% of world population is suffering from 1 type of diabetes or other. This is due to our lifestyle which does not include any type of physical exertions to burn the intake calories. The prevailing method to test blood sugar level is to take out an appreciable quantity of blood from the body or to prick the finger to take a drop of blood

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to monitor blood sugar through glucometer. The objective is an attempt to monitor the approximate level of sugar through urine. This method is beneficial as it neither is painful nor results in blood loss.
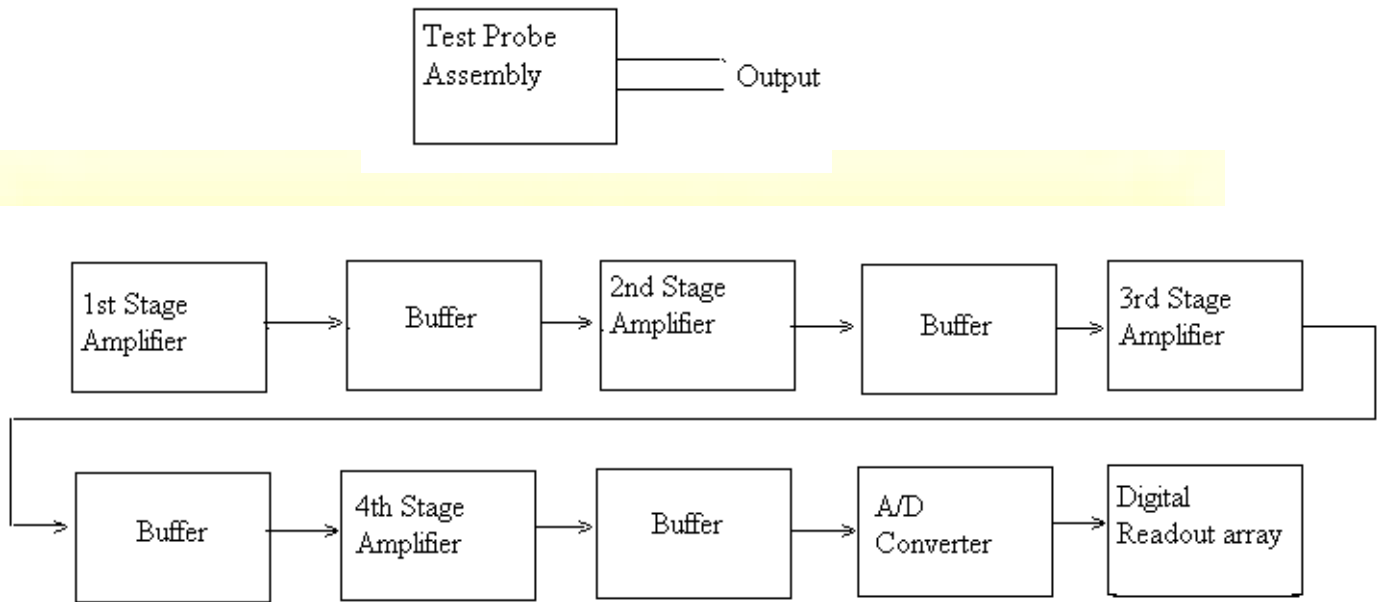

Fig 7: Block Diagram of Quadruple Amplifier

A common use for a buffer is to supply current to another stage of a design, where the buffer acts as a gateway. So when the buffer "sees a voltage at the input, it will output the voltage, but will also drive that voltage with current (as much as you want for an ideal op amp). This would be useful if you have a weak signal at the input, but want to let some other part of a circuit know about it. Perhaps you have a small sensor that is outputting a small voltage, but then you want to send the voltage over a long wire. The resistance in the wire will probably consume any current the sensor is outputting, so if you put that signal through a buffer, the buffer will supply the necessary current to get the signal to its destination (the other end of the wire).

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